2005 Whipple Creek Stream Assessment
Summary

Clark County Public Works
Water Resources Section

July 2005

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Funded by the
Clark County NPDES Clean Water Program

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Executive Summary

Background
This report summarizes the planning, implementation, and products of the Whipple Creek Stream Assessment project. Several watershed-scale characterization maps are also included, as are lists of immediate problem referrals and potential areas for preservation.

From December 2004 through May 2005, Clark County Public Works Water Resources assessed 25 stream miles in the Whipple Creek watershed for stormwater impacts and stream improvement opportunities.

Methods
The Whipple Creek Stream Assessment utilized the Unified Stream Assessment (USA) protocol designed by the Center for Watershed Protection (March 2004) for EPA's Office of Water Management. The USA is part of a larger set of protocols developed by the Center as an integrated framework for improving and rehabilitating small urban watersheds.

The USA is a systematic technique to locate and evaluate problems and restoration opportunities within the urban stream corridor. Taken in conjunction with other watershed data, results of the USA may be used to develop urban stream restoration plans.

The project focused first on the more heavily developed upper watershed, followed by the more rural Packard Creek tributary.

A letter of intent was sent to 398 property owners bordering Whipple Creek, explaining the project and notifying landowners of the county's plans to access these properties. The letter announced the county's intentions and placed the responsibility on landowners to respond if they wished to deny access. Only five landowners chose to decline access, with an additional 20 landowners calling in support of the project or to request prior notification so animals could be penned or landowners home at the time of the assessment.

A press release was also issued at the beginning of the project in an effort to increase public awareness, eventually leading to an article featuring the project in the Columbian newspaper.

Results
Figure 1 shows the location of the assessed catchments within the Whipple Creek watershed. Approximately 25 miles of stream corridor were assessed, including 56 complete catchments and 4 partial catchments.

Primary products from the assessment included:
1) a SQL database populated with complete assessment data
2) a geodatabase including location data for all assessed features, linked to the SQL database
3) an initial tally of assessed features and restoration opportunities, summarized by reach

In addition to these required products, the project led to a number of general impressions regarding the Whipple Creek watershed, a list of problems for immediate referral, and a list of areas where preservation of existing habitat should be considered. Several watershed characterization maps were also generated based on assessment data.

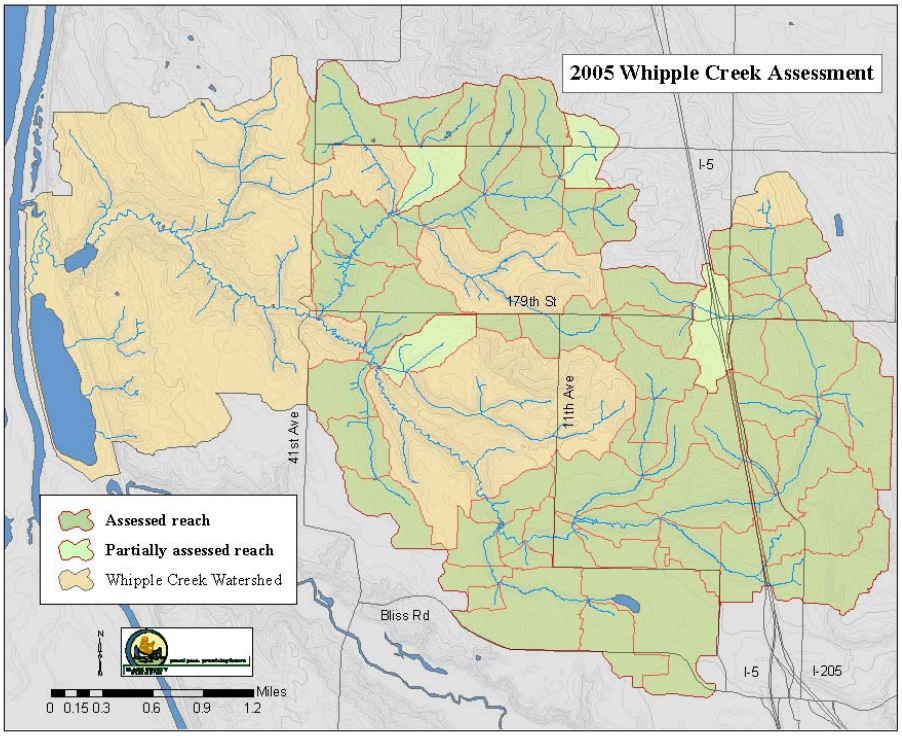

Figure 1. Whipple Creek Stream Assessment reaches, 2005.

The Whipple Creek Stream Assessment generated a large amount of information that should be an integral component of stormwater planning in the Whipple Creek watershed and other projects.

Potential projects are numerous. Out of the 544 assessed features, over 300 were ranked as possible opportunities to improve the stream. These potential projects vary widely in type, cost, and priority; however, this number provides an indication of the amount of improvement work that could be done in the assessed reaches.

Opportunities involving county stormwater infrastructure are primarily associated with stormwater outfalls and stream crossings. Forty-one outfalls and 72 stream crossings were assessed as project opportunities.

Erosional features were numerous, with long segments of stream scour and incision very common.

Impacted buffers were also very common, and 83 of 87 assessed impacts were ranked as possible projects. Buffer improvement opportunities tend to focus on invasive plant removal and streambank re-vegetation, and in many cases could be combined with erosion-related improvements. Buffer opportunities involving animal access issues were infrequent.

Channel modifications were relatively infrequent and only 10 potential projects were recorded. Eighteen trash and debris sites were located during the assessment. None of the eight utility features assessed appeared to require restoration projects.

An additional result of assessment activities was the discovery of various issues or situations in need of timely referral for corrective action. Referrals ranged from incomplete stormwater infrastructure mapping to the presence of rare species, and included several imminent or existing threats to stream health. In particular, several erosion control problems and one long-running illicit discharge were discovered and subsequently addressed.

Conclusion

In general, the assessment confirms that the Whipple Creek corridor has been heavily impacted by past and current human activities. Within the assessed reaches, degraded areas far outnumber those that remain intact. In many reaches, increased runoff from historical clearing and development has led to significant channel incision and floodplain disconnection. Streambank scour and fine sediment accumulation are common. Riparian conditions are mixed: many areas have ample vegetated buffer widths, yet a large portion of the vegetation is comprised of invasive species, particularly Himalayan blackberry.

Degradation is not limited to developed or developing areas. Impacts were clearly present in the more rural areas despite significantly lower levels of development and infrastructure. Historical clearing of forest for agriculture, road-building, and timber harvest appears to have altered hydrologic conditions sufficiently to cause channel impacts. Our observations are consistent with current knowledge regarding stream channel impacts: both forest conversion *and* increased development cause significant degradation.

In any case, Whipple Creek serves as a good example of the extent to which human activities can degrade stream function and habitat.

2005 Whipple Creek Stream Assessment
Summary Report

Project Name: Whipple Creek Stream Assessment
Project Type: Monitoring and Evaluation
Accounting Number: 4420-000-531-534-203- RC #011129
Cost: ~$65,000
Schedule: December 2004 - May 2005
Associated Documents: Whipple Creek Stream Assessment Project Plan

Introduction

Report Purpose

This report summarizes the planning, implementation, and products of the Whipple Creek Stream Assessment project. It describes project design, field methods, products, and field observations, including a general project evaluation. Because the assessment was intended to provide tools for use by other projects, data analysis is general and limited. Several watershed-scale characterization maps are included, as are lists of immediate problem referrals and potential areas for preservation. Additional detailed analysis of Whipple Creek Stream Assessment data will be performed according to the needs of the projects listed below.

Project Purpose

From December 2004 through May 2005, Clark County Public Works Water Resources assessed 25 stream miles in the Whipple Creek watershed for stormwater impacts and stream improvement opportunities. The assessment was performed in support of three projects required under Clark County's NPDES permit (WA-004211-1, July 1999):

1) Whipple Creek Watershed Projects Plan. Clark County is required to develop stormwater plans under special permit condition S9.E.1. Whipple Creek Stream Assessment data are to be analyzed and used in conjunction with other watershed information to identify and prioritize stream improvement activities for the Whipple Creek Watershed Projects Plan.

Components of the Whipple Creek Watershed Projects Plan require considerable analysis and mapping of Whipple Creek Stream Assessment data. The watershed-scale characterization maps and many of the other results included in this summary are intended primarily to support the watershed projects plan. Detailed analysis concerning specific project opportunities and prioritization are included in the Whipple Creek Watershed Projects Plan.

Assessment information will also be included in an ArcReader product developed for the Whipple Creek Watershed Projects Plan. ArcReader enables users who are not equipped with ArcMap GIS to view GIS information, and will enhance data usability by a variety of interested parties.

2) Illicit Discharge Detection and Elimination. Ongoing illicit discharge screening is required under permit section S5.B.8.g.ii. The Whipple Creek Stream Assessment documented the location and conditions of storm sewer outfalls within assessed stream reaches, and provides a basis for future IDDE implementation in the Whipple Creek watershed.

3) Storm Sewer Mapping. Storm sewer mapping is required under special condition S5.B.6. Water Resources' storm sewer mapping activities have been ongoing for several years. The

Whipple Creek Stream Assessment documented the location of previously unmapped stormwater infrastructure and provided limited ground-truthing for previously mapped areas.

The Unified Stream Assessment

The Whipple Creek Stream Assessment utilized the Unified Stream Assessment (USA) protocol designed by the Center for Watershed Protection (March 2004) for EPA's Office of Water Management. The USA is part of a larger set of protocols developed by the Center as an integrated framework for improving and rehabilitating small urban watersheds.

The USA is a systematic technique to locate and evaluate problems and restoration opportunities within the urban stream corridor. Data are collected for nine components along each assessment reach: eight impact assessments and one reach assessment. Impact assessments document storm water outfalls, severe erosion, impacted stream buffers, trash and debris, utilities in the stream corridor, stream crossings, channel modifications, and miscellaneous features. They are designed to collect basic data on the location, condition, and potential restorability of individual features present in the stream corridor. Reach assessments summarize overall stream corridor conditions within each reach.

Maps and calculated metrics provide a preliminary assessment of problems and opportunities for stream improvement or rehabilitation for each reach and the watershed as a whole. Taken in conjunction with other watershed data, results of the USA may then be used to develop urban stream restoration plans.

Project Description

Objectives

The primary objectives of the Whipple Creek Stream Assessment were to:

1) Provide USA assessment data for approximately 25 stream miles at a catchment scale.
2) Locate and map county stormwater outfalls and non-county outfalls within the assessed catchments.

Additionally, the project presented an opportunity for Water Resources to assess the overall suitability of the USA protocol for identifying potential stormwater or stream habitat improvement projects and providing information for future stormwater planning efforts.

Scope

For planning purposes, the watershed was divided into 4 general areas: 1) Upper watershed (above 157th Street), 2) Middle watershed (Packard Creek confluence to 157th St), 3) Packard Creek, and 4) Lower watershed (below Packard Creek confluence).

The project plan intended to focus first on the more heavily developed upper watershed, followed by the middle watershed, Packard Creek, and the lower watershed.

Based on LiDAR (Light Detection and Ranging) topographical mapping data, the Whipple Creek watershed includes approximately 50 miles of perennial stream channel. The project target was to assess ~25 miles of stream corridor; however, it was anticipated that the total mileage assessed would depend heavily on the accessibility of private property and on conditions encountered in the field. The project plan suggested these general priorities:

Upper watershed:

- All accessible stream reaches found on the LiDAR stream layer will be assessed.

Middle watershed:

- Mainstem and major tributary reaches (>1/2 mile in length) will be assessed. Smaller tributaries may be assessed if field conditions indicate significant impacts, or if the tributary drains an area suspected to be a source of impacts.

Packard Creek:

- Same as middle mainstem

Lower watershed:

- Only mainstem reaches will be assessed. Tributary reaches may be assessed if field conditions indicate significant impacts.

Final decisions regarding whether to assess a specific reach were made by crews in the field and by the project manager based on professional judgment.

Products

The Whipple Creek Stream Assessment was primarily a data gathering effort intended to compile tools to be used by other projects. This project provided field assessment data, GIS data showing the location of each assessed feature, and an initial tally of assessed features and stream improvement opportunities. The following specific products were produced by the Whipple Creek Stream Assessment:

1) a SQL database populated with complete assessment data
2) a Geodatabase including all assessed features, linked to the SQL database
3) an initial tally of assessed features and restoration opportunities, summarized by reach

See the Results section for further information about these products, as well as additional results, analysis, and observations.

Organization and Schedule

Project Team

Agency:	Clark County Public Works Water Resources (Water Resources)	
Project Manager:	Jeff Schnabel	
Clients:	Jim Soli and Rod Swanson	
Program Supervisor:	Earl Rowell	
Primary Team Members:	Jeff Schnabel	Bob Hutton
	Ron Wierenga	Ken Lader
	Jason Wolf	
	Mike Szwaya	

Table 1 lists project tasks and primary staff. Project planning activities began in December 2004, with field assessments conducted over a 10-week period from February 9 through April 15, 2005. Data entry, GIS editing, and quality assurance reviews were performed during April 2005. Products were delivered in May 2005.

Table 1. Project tasks and primary staff.

Task	Primary Staff
Budget issues	Rod and Jim
Stream reach delineation	Mike
Modifications to Access database	Mike
Field map generation	Ken
ArcHydro/database compatibility issues	Mike
Landowner access letter	Jeff, w/Kelli (review by PIO and Pros. Atty)
Press release	Don Strick (PIO)
GPS setup	Ken, Mike
Field work planning and logistics	Jeff
Field crew	Jeff, Ron, Jason
Data entry into Access database	Jeff, Jason, Bob
GPS data edited as GIS layer	Ron
Geodatabase development	Mike
Project summary and product compilation	Jeff, Mike

Methods

Preliminary project methods are documented in the Whipple Creek Stream Assessment Project Plan. The following describes finalized methods and reflects modifications made during the project.

Sampling Design

The Whipple Creek Stream Assessment was a census-type survey intended to gather information from a large percentage of the sample population (stream reaches), with a primary focus on urban and urbanizing areas where development activities and stormwater infrastructure are most prevalent.

Reach Delineation

Project data are organized into catchment-level reaches. Based on LiDAR topographical mapping data, the Whipple Creek watershed was divided into 102 catchments within an ArcHydro model, each consisting of a stream reach approximately ¼ to ½ mile in length with a drainage area of 100-200 acres.

Each catchment was assigned a unique reach code based on the stream mile marker at the downstream end of the catchment. Whipple Creek catchments were preceded by the label "W", and Packard Creek catchments were labeled "P". Tributary catchments were appended to the end of the mainstem code using a "T" followed by the mile marker, and split tributaries were delineated with a directional label such as "E". Some examples follow:

W8.50 = Whipple Creek mainstem reach beginning 8.50 miles upstream from the mouth.
P1.55 = Packard Creek mainstem reach beginning at 1.55 miles from Whipple Cr confluence
W5.70T0.36E = tributary reach beginning at 0.36 miles upstream from WC confluence.

Private Property Access and Public Notification

A letter of intent (Appendix A) was sent to the owners of 522 taxlots bordering Whipple Creek, explaining the project and notifying landowners of the county's plans to access these properties. Landowners were invited to contact the project manager if they did not wish to grant access

privileges. Prior to distribution, the letter was reviewed and approved by the project clients, county Public Information and Outreach (PIO) office, and county Prosecuting Attorney's office. Responses were entered into Water Resources' landowner contact database and a map was maintained indicating parcels where access was not allowed and where prior contact was requested before entering a parcel.

Landowners were not required to submit a form granting permission for access, meaning that individual landowners were free to change their mind at any time. Field crews were instructed to abide by the decision of landowners at the time of contact, regardless of prior notification. If requested to leave a parcel, crews were instructed to do so immediately.

Additionally, a press release was created prior to project implementation to better inform the public and media interests about the upcoming work effort. This press release eventually led to a feature article in the Columbian newspaper.

Field Procedures

Maps

1) GPS base map: Field crews carried a GPS unit with a base map including roads, streams, waterbodies, storm sewer infrastructure, septic tanks, sanitary sewer lines, contours, and taxlots.

2) Field maps: A set of 11" x 17" field maps was produced as a backup to the GPS. Field maps included ortho-photographs covering each catchment. Field maps were produced based on an index grid, stored in a binder, and appropriate maps selected for each field day.

3) An ArcMap GIS workspace and table depicting landowner permission status was consulted regularly during field event planning.

Equipment

Waders	Cell phone	Two-way radios
Field maps	Copy of authorization letter	Extra pencils/GPS stylus
Digital camera	Laser range-finder	Spare batteries
Field forms binder	Gloves	
Pens/pencils	Parking contacts	
GPS unit	Machetes	
First aid kit	Backpacks	

Field Assessment

Field assessments were completed during a 10-week period between February 7 and April 15, 2005. Field work was limited to three days per week to allow staff time for other ongoing projects. Assessments progressed at the rate of approximately ½ stream mile to 1 stream mile per day, and varied widely depending on terrain, accessibility, and vegetation.

Field data collection was based on the protocols described in Unified Stream Assessment: A User's Manual (Center for Watershed Protection, 2004), Manual 10 in the Urban Subwatershed Restoration Manual series. The protocol included eight impact assessment forms documenting storm water outfalls, severe erosion areas, impacted stream buffers, trash and debris, utilities, stream crossings, channel modifications, and miscellaneous features. Digital photos were taken to document each assessed feature. Finally, reach assessments summarized general stream corridor conditions within each catchment.

Field assessments were performed by teams of two or three staff. In most cases, a two-person crew was sufficient; however, three-person crews were used for safety and convenience when work was performed in remote areas or in areas with difficult access.

The assessment proceeded upstream starting at the bottom of each pre-defined catchment. Impact assessments and photo documentation were performed as features were encountered along the stream corridor. Assessment forms were filled out as completely as possible in the field without greatly hampering upstream progress. Reach assessment forms were completed at the conclusion of each reach or field day with input by two staff members to promote consistent interpretation.

Field crews modified pre-delineated catchments as necessary during the course of field work. In general, modifications of this type were in response to drastically changing channel conditions within a pre-delineated reach. Necessary modifications were then made to the catchment layer in GIS.

The location of each assessed impact was recorded using a Trimble GeoExplorer XT Global Positioning System (GPS) unit. For linear features (erosional areas, impacted buffers, etc), GPS points were logged at the beginning and end of each impacted segment when possible. Distances were estimated using GPS points, laser range-finder readings, and occasional field crew approximations.

Data Management

Field sheets

544 individual impact assessment forms were completed during the project, in addition to 60 reach-level assessments. Data were recorded in pencil on waterproof field forms. A field binder was used to organize data sheets by type during each field day, after which completed sheets were transferred to a master data binder for safekeeping until data entry.

Photos

Nearly 900 digital photographs were taken over the course of field work. Photos were recorded in the field on both a photo log and on the individual impact assessment form to which they pertained. Each photo retained a unique ID number assigned by the camera. Following each field day, the camera was downloaded and photos stored in date-stamped folders. Photos were later linked to map features in the Whipple Creek geodatabase.

Data entry

An Access database specifically designed to store USA data was provided by the Center for Watershed Protection (March 2004). Water Resources modified this database significantly and migrated it into a SQL database format to interface more efficiently with existing Water Resources databases. Data entry forms were created in an Access project to provide a more user-friendly front-end to the SQL database. Data entry forms closely mimicked field forms to facilitate data entry.

Completed field forms were copied and compiled by catchment to facilitate data entry. Reach assessment forms for each catchment were entered first, followed by individual impact assessment forms. Upon entry into the SQL database, a unique ID number was generated for each assessed impact. This unique ID number is used as the primary key to link data in the SQL database with features in the Whipple Creek geodatabase. As each impact form was entered, staff labeled the field sheet with the auto-generated ID number, initialed the field sheet, and placed a check mark on the sheet to indicate a completed entry.

GPS data

GPS data points were recorded for each of the 544 features assessed during the project and linked to the SQL database using the unique ID numbers described above.

GPS data were downloaded following each field day and merged for editing into a GIS workspace containing all GPS points generated by the project. Editing consisted of confirming and reconciling the location of each GPS point with information recorded on the field sheets, linking the point to the appropriate SQL database ID number, and converting GPS points into point, line, and polygon features representing the assessed impacts. This GPS information was then incorporated as feature classes within the Whipple Creek geodatabase.

Field sheets were initialed and highlighted to indicate completed GIS editing.

Quality Assurance

Field

Because qualitative field assessments allow latitude for subjective interpretation, field assessments were conducted by a limited number of staff to promote consistency. Field staff read and familiarized themselves with USA documentation and data collection tips, and relied on continual collaboration in the field to facilitate consistent interpretation All field work was led by professional monitoring staff with experience in a wide variety of field data collection techniques and issues.

Field sheets were organized by type in a field binder, and each completed sheet was labeled with a unique combination of reach code and feature code. Changes to field sheets were initialed by the data recorder or project manager.

Photo logs and field sheets were cross-checked with field maps at the conclusion of each field day, and any necessary modifications or additions to field sheets were performed at this time.

Data entry and GIS editing

All data were manually entered into the SQL database by project staff under the direction of the project manager. All entries from 50% of the catchments were reviewed for accuracy by the project manager and corrections made as needed. Additionally, a few key fields (e.g. the "potential restoration candidate" field) were checked for all entries. Database issues were submitted as necessary to the database manager for corrective action.

Final GPS data for approximately 10% of assessed reaches were reviewed for accuracy by the project manager.

Results

Figure 1 shows the location of the assessed catchments within the Whipple Creek watershed. Approximately 25 miles of stream corridor were assessed, including 56 complete catchments and 4 partial catchments.

The project scope was modified somewhat during implementation in response to field conditions and client priorities. Completion of the highest priority area (upper Whipple Creek and tributaries) required 6 weeks, after which project clients were presented with a series of options for the remaining 4 weeks of field work: 1) focus on assessing the middle and lower mainstem of Whipple Creek and the Packard Creek mainstem, 2) focus on assessing the majority of the Packard Creek mainstem and tributaries, or 3) select specific catchments of interest throughout the watershed.

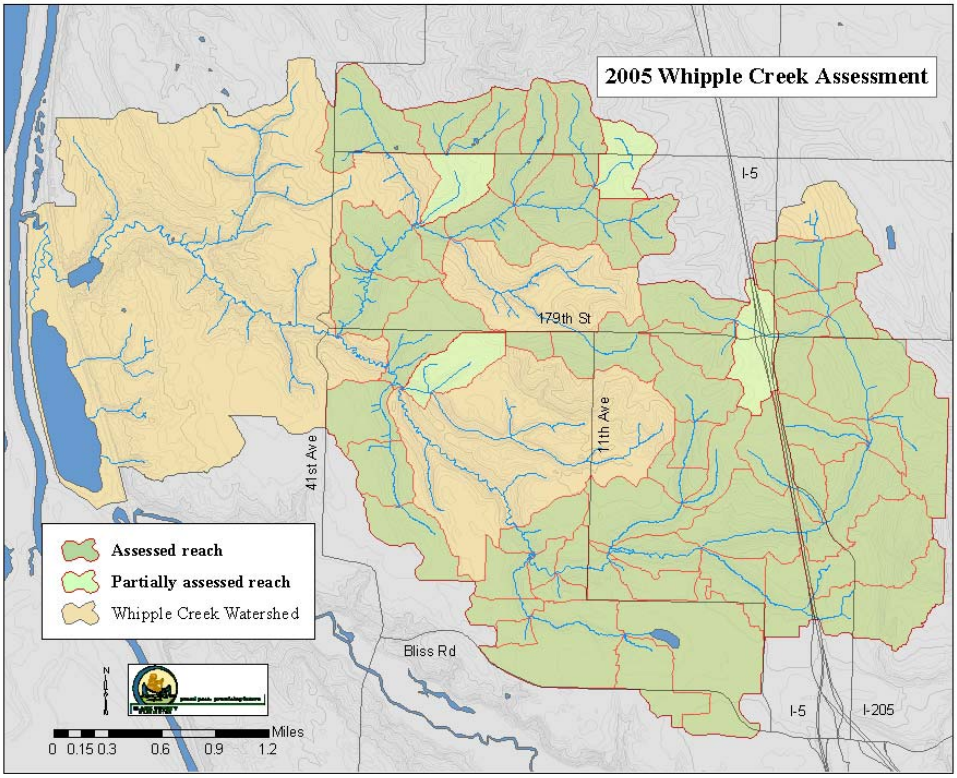

Figure 1. Whipple Creek Stream Assessment reaches, 2005.

The clients chose to focus on assessing as much of the Packard Creek subwatershed as possible. Packard Creek represented a definable area with a set of impacts indicative of a more rural landscape. Packard Creek is also situated in an area where future development is likely to occur. Additionally, the clients selected a single tributary stream in the middle section of the Whipple Creek watershed. This less-developed tributary tended to have similar underlying geology as heavily developed tributaries in the upper watershed and represented a possible opportunity for comparison.

Data limitations

There are limitations to the appropriate use of Whipple Creek Stream Assessment data, primarily in the interpretation of certain types of metrics.

Our application of the protocol focused to a greater degree on locating and documenting the presence of impacts as opposed to providing a detailed interpretation of their severity or level of restoration opportunity. Though experienced in field data collection, field staff were not engineers or stream rehabilitation specialists. Field rankings were based on initial staff impressions and when in doubt rankings tended toward the middle of the range in order to not artificially eliminate unrecognized opportunities. Additionally, field interpretation of problem severity and restoration potential evolved somewhat over the course of the project after a larger number of features were available for relative comparison.

Distance measurements were made with a variety of field and GPS methods that did not always agree. When editing GPS data into the GIS layer, lengths and widths of line and polygon features often required adjustment based on professional judgment.

Given these limitations, two general rules of interpretation should be noted by data users:

1) Severity and opportunity rankings should be interpreted as initial estimates. A ranking of three or above generally indicates staff believed a possible opportunity exists or that the impact is relatively severe. However, an impact ranking "4" may not prove to be a higher priority than one ranked "3". In some cases, further site analysis will be required to evaluate opportunities.

2) Areal and linear calculations of impacts (e.g. acres of impacted buffer, miles of eroded streambank) are initial estimates. More detailed site analysis is required to produce accurate totals for projecting rehabilitation costs.

Products

The following describes the content and location of the primary products (as of June 2005):

1) SQL database:
All project field data are stored electronically in a SQL database on the Water Resources Nt05 server at Network\Langroup\Nt05\WQ\Monitoring\Database\Admin\USA\USA.mdb. Original field sheets and copies used for data entry are also on file at Water Resources. The SQL database is linked to the geodatabase (product #2 below).

2) Geodatabase:
All assessed features are stored electronically in a Whipple Creek geodatabase at \\Nt05\wq\GIS\Data\Hydrography\Whipple\WhippleWatershed.mdb. The geodatabase may be used to generate an atlas-style series of paper maps for detailed examination of project opportunities (Appendix E includes an example map of assessed features).

3) Tally of assessed features:
Appendix B contains a tally of assessed features and potential restoration opportunities, grouped by catchment and feature type. The table may also be found in electronic format at Q:\Monitoring\011129 Whipple Creek Stream Assessment\WC Assessment summary tally.mdb. The tally of assessed features provides a starting point for project selection by the Whipple Creek Watershed Projects Plan.

In addition to the required products, the project led to a number of general impressions regarding the Whipple Creek watershed, a list of problems for immediate referral, and a list of areas where preservation of existing habitat should be considered. Several watershed characterization maps were also generated based on assessment data (Appendix D). These items and the tally of assessed features are discussed below.

Tally of features and opportunities

The table in Appendix B includes a column for each feature type and a row for each assessed reach. Each row shows the number of assessed features of each type, along with the number of potential opportunities for that feature type. Summing across the row gives the total number of project opportunities in that reach.

Each column is also summed to indicate the total number of features and opportunities for each feature type across the entire assessment.

Potential projects are numerous. Out of the 544 assessed features, over 300 were ranked as possible opportunities to improve the stream. These potential projects vary widely in type, cost, and priority; however, this number provides an indication of the amount of improvement work that could be done in the assessed reaches.

Opportunities involving county stormwater infrastructure are primarily associated with stormwater outfalls and stream crossings. Forty-one outfalls and 72 stream crossings were assessed as project opportunities. In many cases, the county already owns the infrastructure and road rights-of-way to allow access to these features. In many cases outfall and stream crossing retrofits or maintenance would provide direct and immediate improvement to overall stream condition in the form of erosion control, flow attenuation, streambank stabilization, and trash reduction. Many stream crossings also present barriers to fish migration. Carefully selected barrier-removal projects could open up significant areas for fish usage.

Erosional features were numerous, with long segments of stream scour and incision very common. Out of 88 assessed features, 60 potential opportunities were recorded. Evaluating the potential for improvement is more complex for erosional features than for outfalls and stream crossings. In some cases, stormwater retrofits or upstream controls may help to slow or eliminate further erosion. However, rehabilitating areas with severely eroded streambanks and re-connecting the channel to its floodplain would often be contingent on the purchase of land or the cooperation of private streamside landowners. Therefore, the best opportunities for large-scale projects to stabilize streambanks may be on publicly owned parcels.

Impacted buffers were also very common, and 83 of 87 assessed impacts were ranked as possible projects. In many cases potential restoration projects would again be contingent on landowner cooperation; however, a good number of opportunities also exist on publicly owned parcels. Buffer improvement opportunities tend to focus on invasive plant removal and streambank re-vegetation, and in many cases could be combined with erosion-related improvements. Buffer opportunities involving animal access issues were infrequent. Those that were discovered were included on a list for immediate referral to the Clark Conservation District.

Channel modifications were relatively infrequent and only 10 potential projects were recorded. These focus primarily on removal of channelizing materials (riprap, concrete). All channel modifications were relatively small (10 to 50 feet in length), and in most cases these opportunities would likely be pursued only in conjunction with larger multiple-benefit projects.

Eighteen trash and debris sites were located during the assessment. These vary widely in their accessibility and size, but all were recorded as potential projects. While some sites would require heavy equipment, most were of a scale appropriate for volunteer groups or county-sponsored corrections-crews. In some cases, landowners could potentially be required to perform cleanup activities through county Code Enforcement. Most or all of these opportunities should be addressed in some fashion: trash removal provides direct benefits to stream health and is a highly visible stream improvement activity.

Among the 87 miscellaneous features recorded, 30 presented a variety of potential projects. These include culvert removal projects, storm water facility maintenance, and potential storm water detention projects, among others.

None of the eight utility features assessed appeared to require restoration projects.

General watershed characterization maps
Three watershed characterization maps were generated by summarizing selected reach level metrics. These maps are included as Appendix D.

- **Map 1)** Reach Level Assessment score for each assessed catchment

  Description: The Reach Level Assessment consists of eight sub-metrics relating to stream and riparian condition. Each sub-metric receives a score from 0 to 20. The total score (0 to 160) indicates overall condition and may be compared between reaches to prioritize high or low quality areas.

- **Map 2)** Bank Erosion and Floodplain Connectivity scores for each assessed catchment

  Description: Bank erosion severity and floodplain connection are two sub-scores within the Reach Level Assessment. These scores address important components of stream condition that are particularly prone to stormwater impacts. Low scores in these two categories often reflect low overall scores for stream condition.

- **Map 3)** Dominant substrate and fish barrier ratings for each assessed catchment

  Description: This map provides basic information on the potential for fish spawning (areas with gravel substrate) and distribution (location of fish passage barriers) in the assessed reaches. As part of the overall characterization, this information may be used to locate particular projects to support fish-related beneficial uses.

Immediate Problem Referrals
An additional result of assessment activities was the discovery of various issues or situations in need of timely referral for corrective action. Such issues were noted by field staff, entered into a tracking spreadsheet with basic information, and referred to appropriate county and agency staff for attention or resolution. The referral list is included as Appendix C and may be found in electronic format at Q:\\\Monitoring\Whipple Creek Stream Assessment\Discussion and Referrals\2005 Whipple Creek referrals.xls.

Referrals ranged from incomplete stormwater infrastructure mapping to the presence of rare species, and included several imminent or existing threats to stream health. In particular, several erosion control problems and one long-running illicit discharge were discovered and subsequently addressed.

Referred issues included:

4 areas with unmapped stormwater facilities	3 erosion control issues
1 opportunity to preserve high-quality habitat	1 stormwater facility repair
1 illicit discharge to the creek	4 wildlife-related inquiries
4 sites with livestock access to the creek	1 commercial debris pile on streambank
4 possible septic system issues	

Not all referred issues have been resolved as of June 2005; however, unresolved issues have been referred to the appropriate staff and followup is ongoing or pending.

General impressions based on field observations
Field crews spent many hours traversing the Whipple Creek stream corridor during the assessment. In addition to the data recorded for individual stream corridor features, a number of

general patterns and issues were noted over the course of the assessment. Portions of the following are compiled from a list of discussion points kept by field staff.

In general, the assessment confirms that the Whipple Creek corridor has been heavily impacted by past and current human activities. Within the assessed reaches, degraded areas far outnumber those that remain intact. In many reaches, increased runoff from historical clearing and development has led to significant channel incision and floodplain disconnection. Streambank scour and fine sediment accumulation are common. Riparian conditions are mixed: many areas have ample vegetated buffer widths, yet a large portion of the vegetation is comprised of invasive species, particularly Himalayan blackberry.

Degradation is not limited to developed or developing areas. Impacts were clearly present in the more rural areas despite significantly lower levels of development and infrastructure. Historical clearing of forest for agriculture, road-building, and timber harvest appears to have altered hydrologic conditions sufficiently to cause channel impacts. Our observations are consistent with current knowledge regarding stream channel impacts: both forest conversion *and* increased development cause significant degradation.

In any case, Whipple Creek serves as a prime example of the extent to which human activities can degrade stream function and habitat. Evidence of past and current impacts is already extensive in this moderately developed (upper watershed ~25% total impervious area, lower watershed ~19%) watershed. There is no evidence to suggest that further development can occur in Whipple Creek without increasing those impacts. On the contrary, continued development will result in ongoing degradation and further destabilization of stream channels, further disruption of habitat, and increased water quality problems.

The Independent Science Panel review of the 2001 Stormwater Management Manual for Western Washington notes that project-by-project mitigation does not address watershed-scale issues such as cumulative impact, and is not sufficient to prevent declining habitat conditions (June, 2003). The report may be viewed at http://www.governor.wa.gov/gsro/science/isprpt2003sum.pdf .

Additionally, section 1.7.5 of the February 2005 Stormwater Management Manual for Western Washington states acknowledges that:

> "… despite the application of appropriate practices and technologies identified in this manual, some degradation of urban and suburban receiving waters will continue, and some beneficial uses will continue to be impaired or lost to new development. This is because land development, as practiced today, is incompatible with the achievement of sustainable ecosystems."
>
> (February 2005)

Given the observed conditions in Whipple Creek and the current state of watershed science, staff believe that management recommendations from the Whipple Creek Watershed Projects Plan should include an acknowledgment of the fact that, under current standards, further development cannot be undertaken without continuing consequences to the health and habitat of Whipple Creek.

Beaver dams

Beaver dams are extensive in the Whipple Creek mainstem and some tributaries. Many have extensive sediment deposition behind them. These sediments are composed of sand, silt, or mud and are often very deep, loose, and unconsolidated. 2004 was an unusually dry winter and the infrequency of storms may have reduced sediment flushing and contributed to unusually deep

sedimentation behind these structures. Both aerobic and anaerobic sediments were observed. In many areas the sediment deposition appears to be filling in deeply incised channels, and it appears that the dams are very important for storing much of the Whipple Creek sediment load.

Beavers appear to take advantage of incised streams. Building dams is easier and the stream tends to remain within its banks and not enter the floodplain. Eventually the sedimentation behind the dams will fill in the channel. Intentional beaver dam removal or floods have the potential to re-mobilize large amounts of sediment.

Water quality is relatively poor in the ponded stream sections. High nutrients, sediments, and warm temperatures lead to stagnant conditions and algal growth. Although the habitat quality in beaver pond areas is excellent in terms of complexity, water quality seems to limit utilization by aquatic organisms. Upstream stormwater control and treatment is important to limiting accumulations of pollutants in these areas.

Wildlife

In addition to beaver, staff observed a moderate amount of wildlife usage of the stream corridor. Evidence of deer, raccoon, song-bird, and waterfowl use was common, in addition to frogs, salamanders, and newts. No anadromous fish, no crayfish, and few resident fish were observed. Two species of interest were noted and reported to fish and wildlife agencies:

Red-legged frog

A field crew noted the presence of a Northern Red-legged frog on March 9, 2005. The Red-legged Frog was recently split into two species -- the California Red-legged, which is on the Endangered Species List, and the Northern Red-legged which occurs in our area. A Northern Red-legged frog was seen at GPS point MI-3 in catchment W6.44T0.00. JoAnne Shute at WDFW noted that the Northern Red-legged is listed as a sensitive species in Oregon and Canada, but is not listed in Washington. However, Ms. Shute also noted the species is likely to make the sensitive list soon as it does not thrive in rapidly developing areas such as Clark County.

Freshwater mussels

Freshwater mussels have been the subject of local US Fish and Wildlife Service surveys and have been recognized as a valuable indicator of stream health for salmonids. A field crew noted the presence of an intact freshwater mussel bed on March 22, 2005. The location is logged as GPS point MI-1 in catchment W3.85. This finding was reported to Jennifer Poirier at USFWS.

Invasive blackberries

Field staff observed patterns in blackberry invasions. It is evident that development project clearing to the edge of valley walls or floodplains impact the fringe of vegetation and that non-native plants establish on this front. In some places encroachment on both sides of the creek allowed the non-native vegetation to bridge the entire floodplain and valley floor. Blackberries encroach to varying degrees from nearly every road crossing, again gaining a foothold in the disturbed soil that accompanies construction activities.

Staff also observed patterns where land was disturbed for utilities such as storm water outfalls. In many places where stormwater outfalls were run-out into the forest or buffer area, blackberries had established along the exact line of disturbed soil. If efforts were made to replant the disturbed zones blackberries had overwhelmed the plantings.

In many areas better vegetation management in the period following disturbance could prevent much larger problems once the invasive species get fully established. In many areas, invasives

(particularly blackberries) appear to be the primary or secondary issue degrading the quality of the Whipple Creek riparian corridor.

Subsurface flow/gully erosion issues

Erosion issues first noted at a stormwater facility for Whipple Creek Place subdivision suggest that concentrated subsurface flow has the potential to destabilize hill slopes, leading to active erosion of the valley walls, floor, banks, and channel. The resulting sediment is available for downstream transport to mainstem creeks where sedimentation can severely limit beneficial uses and alter water and sediment dynamics.

Watersheds along the Columbia Slope, including Whipple Creek, have a structure that is different from the typical bowl or "basin". Tributaries originate on flat plateaus and run off crests and bluffs to stream channels. The steepest sections of these creeks are often mid-length where they crest the plateau edges and rapidly lose elevation to floodplain floors. Valleys and steep drainages tributary to the mainstem creeks were formed over long periods of time and under very different surface and subsurface hydrologic conditions than after development takes place. Because they are often situated in highly erodible soils and underlying geology, they are easily de-stabilized.

It appears that the upland plateau areas are important sinks of water, infiltrating large amounts of rainfall. Land development results in lost infiltration and reduced storage capacity, sending runoff rapidly to steep channels that are not capable of maintaining stability.

Stormwater facilities and outfalls are often located on the last available ground on plateau edges before gullies and valleys begin, leaving little room for energy dissipation. Drainage lines installed to de-water retaining walls, hillslopes, and other structures often provide concentrated flow to steep slopes. These practices appear to reduce the subsurface flow path and result in unstable, channelized gullies as large amounts of shallow groundwater move laterally to valley walls.

Downstream assessment for development projects

Observations made during the assessment led staff to consider the issue of downstream impacts from development activities and the way in which such impacts are assessed and/or mitigated. In a number of cases, downstream impacts such as incision and headcuts appear to have occurred as a result of recent development projects.

County code provides for downstream analysis of stormwater impacts, but data are usually lacking. Results from the Whipple Creek Stream Assessment provide an inventory of known channel stability problems and a basis for performing off-site impact analysis. A potential option to address the issue of unstable channels and downstream impacts would be through the state SEPA process, where assessment results could be incorporated into SEPA review for mitigation.

Stormwater outfalls

Many of the assessed stormwater outfalls, including some road ditches, are causing significant impacts to the stream corridor in the immediate vicinity of the outfall. Common impacts include localized erosion, invasive plant colonization, and trash accumulation. In some cases outfalls are suspected of contributing to dry-weather water quality problems and need to be sampled during future outfall screening activities.

A significant number of outfalls require some degree of maintenance, including replacement or upgrading of energy dissipation structures, clearing of vegetation and sediment clogs, installation

or repair of trash grates, and stabilization of adjacent stream banks. Facilities associated with some of these outfalls appear to be undersized or in need of maintenance to address short-circuited flow paths or poorly established vegetative filters.

Stormwater facility inspections

Issues noted at Whipple Creek Place and other subdivisions led to suggestions that facility inspection protocols may need modification to increase examination of outfalls and potential downslope erosion issues. Current inspections tend to focus on maintenance standards such as mowing and facility structures, with little attention paid to possible impacts on unstable slopes immediately down-gradient from the outlet area.

At Whipple Creek Place, initial attempts to fix a series of holes short-circuiting baseflow and storm flows under a level spreader were unsuccessful, highlighting the need for additional followup inspections especially when short-term fixes are used.

Anecdotal accounts

Conversations with long-time stream side landowners suggest the creek has changed over the past 50 years. Several landowners reminisced about the historical presence of steelhead and sea-run cutthroat trout on their properties. Others noted the disappearance of once-abundant crayfish populations. Recent increases in beaver activity were also reported by a number of residents.

Very few residents complained of rising water levels or increased flooding, though several noted that water backs up behind undersized culverts during storm events and they suspect increased development upstream is contributing.

A number of residents commented they had not been near the creek on their property for years, citing impenetrable blackberry thickets as the reason.

Potential areas for preservation

Though the majority of assessed reaches were moderately to severely degraded, a number of reaches still exhibit relatively intact channel conditions and/or habitat. These intact remnants provide islands of habitat that act as a buffer from surrounding impacted areas. In many cases, the presence of intact areas serves to protect downstream reaches from further damage. Protecting or enhancing intact streams is generally considered more cost-effective than attempting to "fix" streams after they are degraded. For that reason, opportunities to purchase, set-aside, or otherwise protect intact stream reaches should be actively pursued.

Table 2 is a list of 12 relatively high-quality stream reaches that should be a priority for preservation. The table includes the Reach Level Assessment score (0 – 160) and a brief comment describing reasons the reach may be worth protecting.

Reaches were selected for various reasons, including opportunities to:

- connect or extend high-quality reaches already under county ownership
- protect intact wetland areas from encroaching development
- protect areas where sensitive habitats or rare species were encountered (e.g. Northern red-legged frog)
- contribute to ongoing efforts by the county to purchase remnant pieces of excellent habitat, and;
- preserve or enhance areas where future salmonid re-introduction could occur

In many cases multiple landowners control the property within each reach, making the purchase of large areas of contiguous habitat potentially challenging. Regardless, the county should be aware of these areas and be prepared to take advantage of opportunities that may arise. In some cases landowners could be provided with information describing options for the preservation of their creek-side properties (federal programs, The Nature Conservancy, Columbia Land Trust, and others).

One opportunity from Table 2 was included in the list of immediate referrals from the project. Large parts of reach W7.82 and reach W8.36 are included in a 40-acre parcel owned by the Van Buren family. County and state habitat biologists recognize this property as perhaps the highest quality habitat remaining within the Whipple Creek watershed. In response to issues stemming from the proposed development of this land, the county has pursued funding sources to make possible the purchase of the property. The Clean Water Program is exploring the possibility of contributing to the purchase and enhancement of this property.

Table 2. Priority reaches for preservation/protection

Reach Code	Reach ID	Reach Score	Comments
W5.70T1.08E	43	127	county-owned; large pond/marsh complex controlling stormwater for large area and protecting downstream channel; adjacent wetland recently filled for new development
W6.41	46	138	large series of beaver ponds and wetland complex in good condition
W6.44T0.00	59	115	many groundwater seeps; upper part forested; Northern red-legged frog observed
W6.44T0.75N	57	126	partially county-owned; intact forest with some large trees
W7.82	50	133	partially county-owned; part of reach lies on Van Buren property which was referred as a high priority for purchase
W8.36	51	131	likely the best remaining habitat in watershed; reach lies primarily on Van Buren property noted above; beaver pond complex throughout reach; recognized as prime habitat by county and WDFW
W8.50	60	113	property immediately north of Van Buren (Milton Brown); lower end is intact beaver ponds/wetland complex providing stormwater control; threatened by surrounding development
W8.50T0.00	52	127	intact wetland on Milton Brown property is threatened by planned developments; upland has been logged in past 10 years but stream and wetlands are high quality
W9.14	66	134	headwater stream in good condition currently, but vulnerable to futureI-5 corridor development impacts
W9.31	67	--	High quality headwater wetland; vulnerable to future I-5 corridor development impacts; high priority for preservation/protection; no score given due to lack of defined channel
P0.00*	76	110	impacted, but one of few potentially accessible reaches with gravel substrate; also storage opportunity along flat riparian area near mouth
P1.06*	80	98	impacted, but one of few potentially accessible reaches with gravel substrate

* P0.00 and P1.06 are included primarily because these reaches are among a very few areas with gravel substrate where future salmonid spawning might occur. Both reaches, and the reach that lies between them (P0.55), have significant impacts and would require fairly extensive rehabilitation.

Project Evaluation/Observations

As the first project of its kind performed by Clark County, the Whipple Creek Stream Assessment provided an opportunity to evaluate a new method for obtaining stream corridor information. The final section of this summary notes a variety of successes, challenges, limitations, and observations that may be used to refine future projects of this kind.

Overall

The Whipple Creek Stream Assessment generated a large amount of information that should be an integral component of stormwater planning in the Whipple Creek watershed and other projects. A final assessment of the applicability of the protocol to Water Resources planning needs will be made pending the outcome of the Whipple Creek Watershed Projects Plan.

Initial staff impressions suggest the protocol is most suited to assessing impacts in urban and urbanizing streams where development activities and stormwater infrastructure are most prevalent. Areas dominated by rural land uses may be better suited to a different protocol or a streamlined version of the USA.

The protocol appears to be very successful at discovering and documenting stream corridor features. Many features assessed through this project were previously unknown, and a large number of potential areas for improvement were documented. In fact, opportunities likely far outpace available funding and staff availability, suggesting that the subsequent prioritization of potential projects will be vital to the efficient allocation of funding.

The assessment produced a large body of digital photographs. Many of these photos are being used to educate the public about non-point source pollution, in addition to providing valuable information about each assessed feature.

Property access/public response

Property access issues were virtually non-existent. 398 letters were mailed to the owners of 522 tax parcels bordering Whipple Creek. Rather than requesting access permission, the letter simply announced the county's intentions and placed the responsibility on landowners to respond if they wished to deny access. Because this approach had not been previously attempted by Water Resources, the extent and tone of public response was a matter of some concern.

Twenty-five landowners responded by phone, a response rate of sixteen percent. Only 5 landowners denied access and the remainder were calling in support of the project or to request prior notification so animals could be penned or landowners home at the time of the assessment.

Numerous landowners were also contacted in the process of securing permission to park vehicles. With rare exceptions, landowners were very accommodating. This exercise also led to opportunities to discuss the project with watershed residents.

A press release was issued at the beginning of the project in an effort to increase public awareness. An unplanned benefit of the press release was the opportunity for several staff to participate in a field demonstration and interview with a local reporter, leading to the publication of an article in The Columbian newspaper discussing the influence of rapid development on Whipple Creek.

Field work

Field work proceeded more slowly than anticipated, due primarily to heavy vegetation growth (particularly Himalayan blackberry) and difficult terrain in many areas of the stream corridor.

The USA protocol suggests field work progresses at a rate of 1.5 to 2.5 stream miles per day, depending on the terrain. Pre-project estimates for the Whipple Creek Stream Assessment assumed a rate of 1 to 1.5 miles per day. Actual rates averaged 0.5 to 1 mile per day, and probably represent a reasonable estimate for most urbanizing Clark County streams.

Consistent data collection was a challenge for field crews, despite the use of a limited number of staff as field personnel. A number of opportunities were noted to enhance consistency and efficiency in data collection, including:

- Distance measurements should be made carefully and cross-checked with GPS points when possible. Logging a GPS point at the beginning and end of each linear feature is preferable to a single point and distance estimate.
- A maximum width should be set for impacted buffer estimates, reflecting required habitat buffer widths where appropriate.
- Some elements of the field sheets are duplicative and/or unclear. Some of these were addressed during the project, but additional modifications would improve field and data entry efficiency.
- Based on information needs identified by project clients, limited revisions to the reach assessment or other field sheets could increase the applicability of the assessment. For instance, a standard metric for bank stability could be added to the reach assessment.
- A consistent approach to grading stream crossings as fish barriers should be applied to every crossing regardless of location within the assessment reach. For instance, a consistent grade should be applied to all beaver dams.

Weather was unseasonably warm and dry during the assessment period. Wet weather could have a significant impact on an assessment, primarily due to its effect on stream depth and field operations. Water quality issues (e.g. turbidity, storm sewer discharge impacts) may have been underestimated due to the dry weather. The extent of vegetation growth encountered between February and April suggest that such an assessment would be impossible to conduct during the summer months. An earlier start date, such as January, would improve the likelihood that crews finish the allotted work prior to the onset of extensive vegetation growth.

Safety

Stream assessment requires hard physical labor on the part of field crews. Safety concerns are numerous, including steep slopes, slippery footing, fences, extremely thick and/or hazardous vegetation (blackberry, nettle), extensive machete use, heat, cold, and unexpectedly deep water. Fortunately, the project did not result in any serious or permanent injuries to staff. However, one staff member sustained an ear injury requiring medical attention, and staff experienced numerous falls, cuts, bruises, and strained muscles.

To minimize the likelihood of injury, crews must be in good physical shape and be experienced in traversing streamside areas. Clients, project managers, and field staff need to be aware of the inherent risks and take reasonable precautions. Regardless of the level of field crew experience, staff injuries will remain a very real possibility.

Sufficient field time must be budgeted so that crews are not compelled to rush or take chances in order to complete their work. Time pressures may lead to unnecessary risks and/or the omission of important features from the assessment. If in doubt about a potential hazard (landowner, dogs, impenetrable blackberry thicket) crews should be encouraged to take time to assess the best approach, which may include turning back.

Data entry

Data entry proceeded more quickly and smoothly than anticipated. However, slight discrepancies between the design of the field sheets and the data entry form resulted in a higher number of entry errors than expected. Minor design adjustments and data validation checks embedded in the data entry forms would be helpful. Removal of certain marginally useful fields would also expedite data entry and improve accuracy.

Acknowledgements

Special thanks to Ron Wierenga and Jason Wolf for long hours of field work and for their many contributions to all aspects of this project. Mike Szwaya and Ken Lader went to great lengths in preparing databases, GPS equipment, field maps, and products. Bob Hutton assisted with a substantial data entry task.

The project benefited from the assistance of virtually every member of the Water Resources section, as well as Don Strick from the PIO office. Thank you to all who participated.

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Appendix A--- letter of intent

January 24, 2004

Name
Address

Dear xxxxxx xxxxxxx:

Clark County's Clean Water Program is planning to conduct a stream assessment in Whipple Creek and its tributary streams during February and March, 2005. The assessment will cover approximately 25 miles of stream channel, a portion of which may lie on or near your property. This includes taxlot # xxxxxxxxxxx as well as any additional taxlots under your ownership within the study area.

Information gained through the assessment is critical to improving water quality in the Whipple Creek watershed. We will use it to upgrade county storm sewer maps, locate storm sewer outfalls, find severe erosion problems, and identify potential sites to improve stream habitat or manage stormwater more effectively.

The assessment requires no removal of rocks, dirt, or plants, and no markers will be left on your property. Depending on the length of stream, we anticipate that field crews of two or three persons will need to access your property for as little as a few minutes and not more than an hour or two on one day only. Crews will confine their assessment activities to the stream and streambank areas.

Field crews are insured by Clark County and will proceed with caution to avoid common streamside hazards; however, if you are aware of an extreme hazard on your property, please notify me as soon as possible.

Your cooperation is appreciated and helps ensure the success of this project. Project results will enable the Clean Water Program to better serve you and your neighbors by addressing stormwater issues and improving water quality in Whipple Creek.

If you have questions or concerns about this project, or prefer that we do not access the stream on your property, please contact me at 360-397-6118 x4583.

Sincerely,

Jeff Schnabel
Water Resources Scientist

Appendix B – Tally of features

2005 Whipple Creek Assessment
Tally of Assessed Features and Restoration Opportunities

	Outfalls		Erosion		Impacted Buffer		Channel Modification		Stream Crossing		Miscellaneous		Utility Impact		Trash/Debris		TOTAL	
ReachCode	#	Restoration	#	Restoration	#	Restoration	#	Restoration	#	Restoration	#	Restoration	#	Restoration	#	Restoration	#	Restoration
P0.00	0	0	4	1	2	2	1	1	1	1	3	0	0	0	0	0	11	5
P0.55	1	1	3	3	1	1	1	0	4	2	4	3	0	0	0	0	14	10
P1.06	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1
P1.06T0.00N	2	0	1	1	0	0	0	0	2	2	0	0	0	0	0	0	5	3
P1.06T0.49W	2	1	3	2	3	3	3	3	7	6	5	2	0	0	3	3	26	20
P1.06T0.57NE	0	0	1	1	3	3	1	1	2	2	1	0	0	0	0	0	8	7
P1.06T0.57NW	3	0	1	0	3	3	0	0	3	3	0	0	0	0	0	0	10	6
P1.23	0	0	2	2	5	5	1	0	3	2	3	1	0	0	1	1	15	11
P1.23T0.98S	0	0	1	1	2	2	1	1	1	1	0	0	0	0	0	0	5	5
P1.67	1	1	3	0	5	5	1	1	3	2	4	1	0	0	1	1	18	11
P1.67T0.00	0	0	5	2	2	2	0	0	2	2	2	0	0	0	0	0	11	6
P1.67T0.34	1	1	2	2	1	1	1	1	3	3	1	0	0	0	0	0	9	8
P2.06T0.00E	2	0	1	1	1	1	0	0	2	2	0	0	0	0	0	0	6	4
P2.06T0.00N	2	1	2	1	4	3	2	0	5	5	2	0	0	0	0	0	17	10
P2.16	1	0	1	0	1	1	0	0	3	3	0	0	0	0	0	0	6	4
P2.51	1	1	1	1	2	2	1	0	1	1	0	0	0	0	0	0	6	5
W3.85	0	0	0	0	1	1	0	0	5	1	2	0	0	0	0	0	8	2
W4.00T0.00	0	0	2	1	1	1	0	0	3	3	3	0	1	0	0	0	10	5
W4.00T0.37	1	0	1	1	3	3	2	0	3	2	2	1	1	0	1	1	14	8
W4.00T0.79	0	0	0	0	1	0	1	0	0	0	1	1	0	0	0	0	3	1
W4.09T0.00	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	1	1
W5.50	0	0	2	1	2	2	0	0	2	0	2	0	0	0	0	0	8	3
W5.70	0	0	1	1	2	2	1	0	5	1	0	0	0	0	0	0	9	4
W5.70T0.00	1	1	3	2	3	3	1	0	4	2	0	0	0	0	0	0	12	8
W5.70T0.36	0	0	2	1	1	1	0	0	0	0	1	1	0	0	0	0	4	3
W5.70T0.49E	4	4	3	2	2	2	1	1	3	1	3	0	1	0	3	3	20	13
W5.70T0.49S	2	2	1	1	0	0	0	0	0	0	0	0	0	0	0	0	3	3
W5.70T1.08E	10	1	1	0	0	0	0	0	0	0	1	0	1	0	1	1	14	2
W5.70T1.08S	3	3	3	2	2	2	0	0	0	0	1	0	0	0	0	0	9	7
W5.99	0	0	4	4	1	1	0	0	2	1	0	0	0	0	0	0	7	6
W5.99T0.00	1	0	1	1	0	0	0	0	1	0	0	0	0	0	0	0	3	1

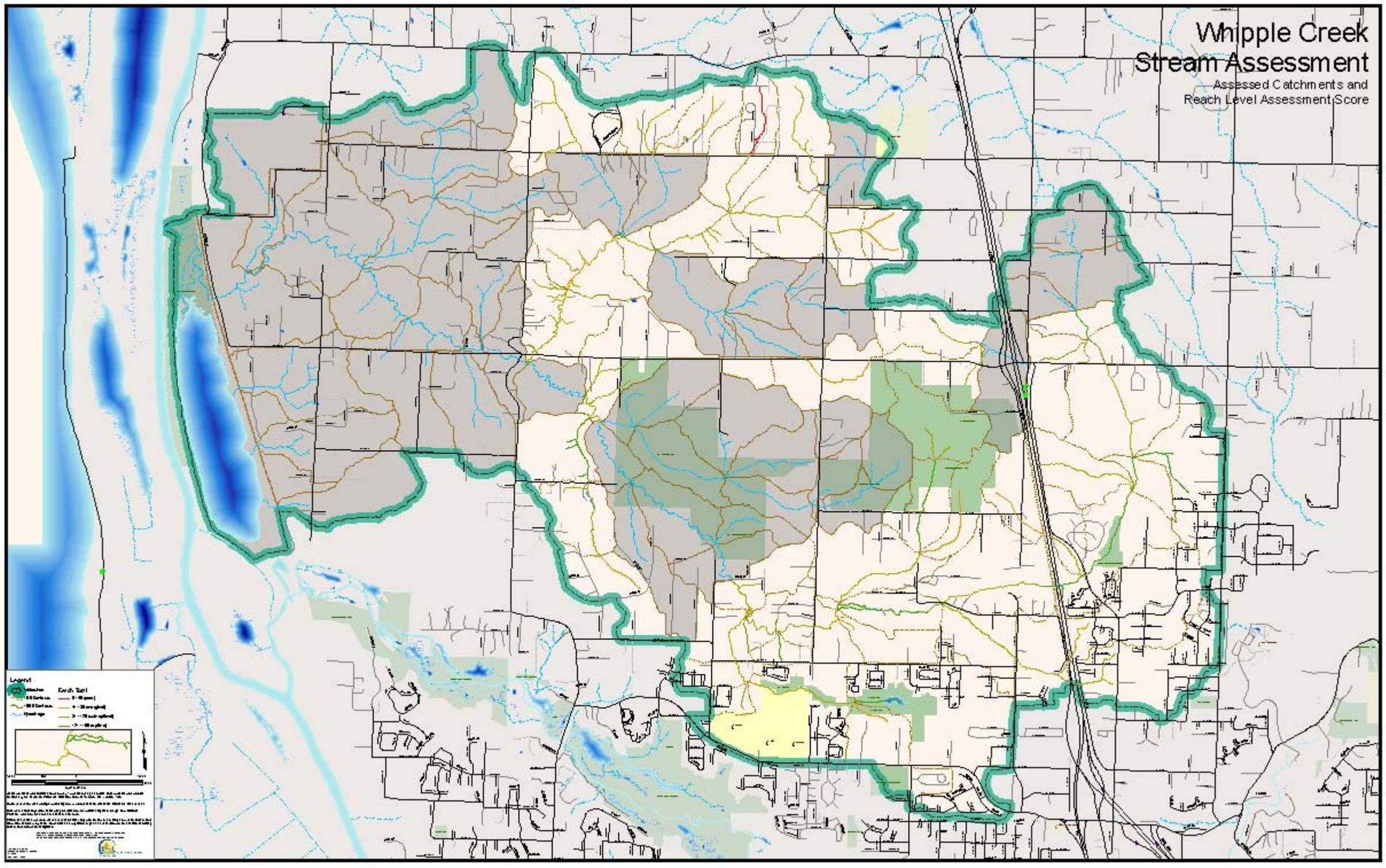
	Outfalls		Erosion		Impacted Buffer		Channel Modification		Stream Crossing		Miscellaneous		Utility Impact		Trash/Debris		TOTAL	
ReachCode	#	Restoration	#	Restoration	#	Restoration	#	Restoration	#	Restoration	#	Restoration	#	Restoration	#	Restoration	#	Restoration
W6.20	1	0	0	0	0	0	0	0	3	0	1	1	0	0	0	0	5	1
W6.26T0.00	1	1	3	3	0	0	0	0	0	0	2	1	0	0	0	0	6	5
W6.41	0	0	0	0	2	1	0	0	5	0	0	0	0	0	0	0	7	1
W6.44T0.00	0	0	1	1	2	2	0	0	4	1	3	0	0	0	0	0	10	4
W6.44T0.53E	5	0	1	0	2	2	0	0	2	2	1	1	0	0	0	0	11	5
W6.44T0.53N	1	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	3	3
W6.44T0.75N	2	0	2	1	0	0	0	0	0	0	2	0	0	0	0	0	6	1
W6.44T1.01N	4	0	1	1	1	1	0	0	0	0	0	0	1	0	1	1	8	3
W7.06	4	3	3	3	3	3	0	0	11	1	5	1	0	0	0	0	26	11
W7.06T0.00	2	2	3	3	3	3	0	0	10	2	2	0	0	0	1	1	21	11
W7.06T0.48	1	0	2	2	1	1	0	0	8	2	2	1	0	0	1	1	15	7
W7.06T0.74N	5	3	1	1	1	1	0	0	0	0	3	3	0	0	0	0	10	8
W7.06T0.74S	5	2	0	0	1	1	0	0	0	0	1	1	0	0	1	1	8	5
W7.68	3	2	2	1	2	2	1	0	1	1	0	0	0	0	0	0	9	6
W7.82	3	2	3	1	3	2	1	0	0	0	5	1	0	0	0	0	15	6
W7.82T0.00	2	1	1	0	1	1	0	0	1	1	0	0	0	0	1	1	6	4
W7.82T0.22	6	1	2	1	3	3	0	0	3	2	3	1	0	0	1	1	18	9
W8.36	0	0	0	0	0	0	0	0	2	0	2	0	0	0	0	0	4	0
W8.36T0.00	2	0	2	2	0	0	0	0	2	2	0	0	0	0	1	1	7	5
W8.50	3	2	1	1	1	1	1	1	5	1	6	3	1	0	0	0	18	9
W8.50T0.00	2	1	1	1	0	0	0	0	1	1	0	0	0	0	0	0	4	3
W9.00	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1	0
W9.14	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0
W9.14T0.00	1	1	2	2	1	1	0	0	2	2	1	1	1	0	1	1	9	8
W9.14T0.29	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2	2
W9.14T0.54N	0	0	0	0	1	1	0	0	4	3	4	3	0	0	0	0	9	7
W9.14T0.54S	4	1	1	0	2	2	0	0	1	1	2	1	0	0	0	0	10	5
W9.31	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1
W9.31T0.00	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1
	96	**41**	**88**	**60**	**87**	**83**	**22**	**10**	**138**	**72**	**87**	**30**	**8**	**0**	**18**	**18**	**544**	**314**

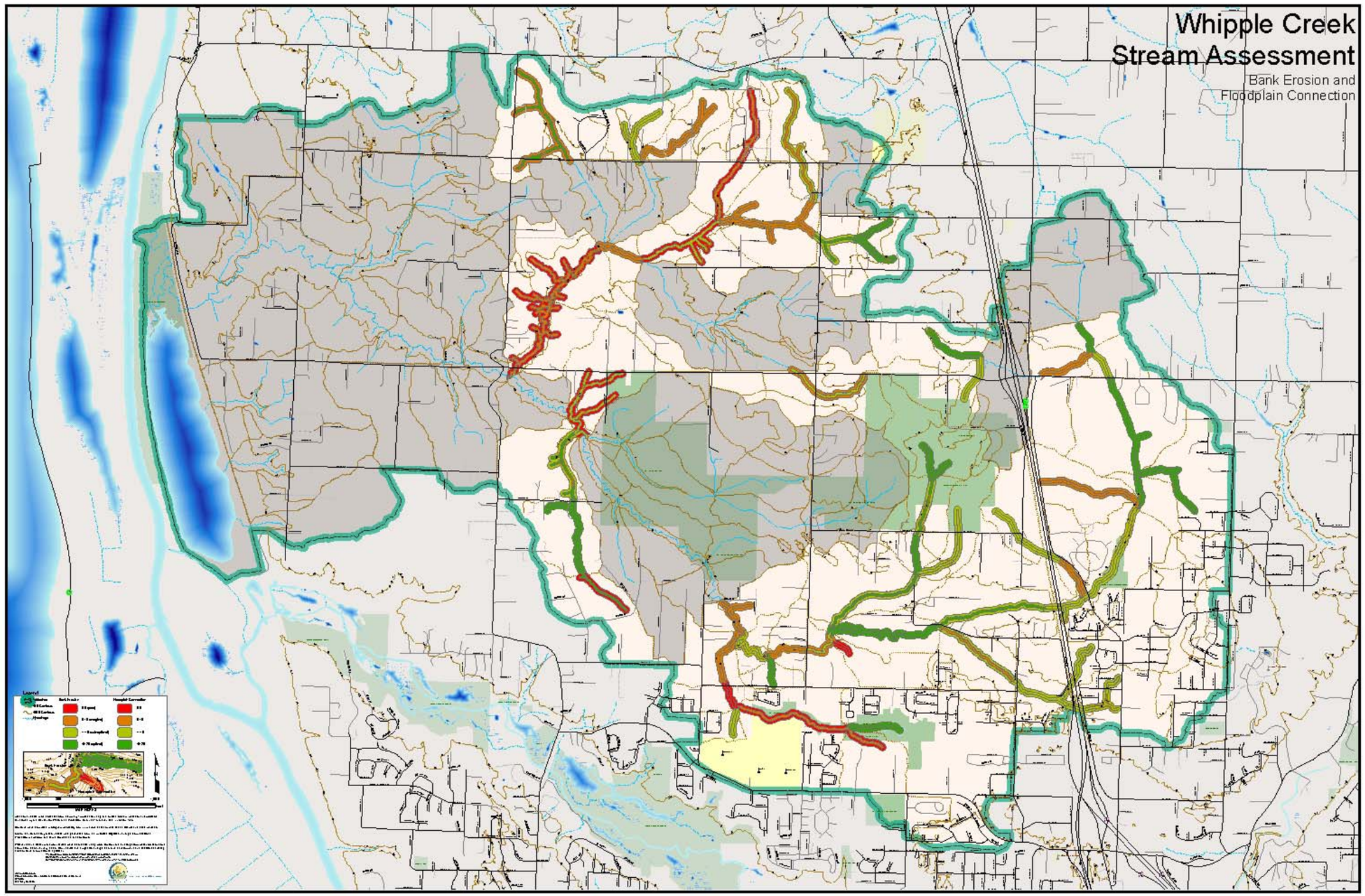
Appendix C – Referrals

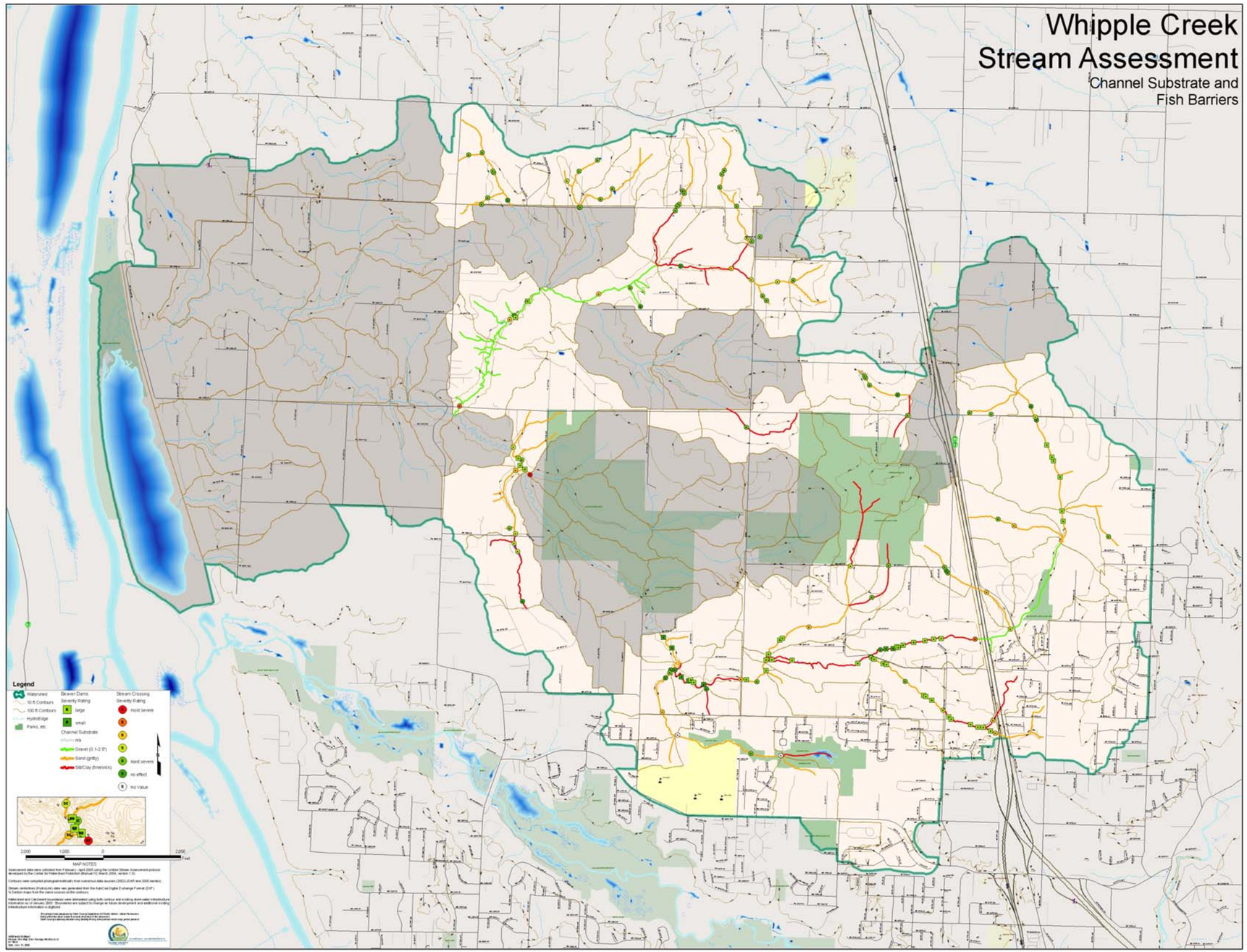
2005 Whipple Creek Assessment Referrals

ReferralDate	IssueDescr	Assessment ReachID	ParcelSN	ParcelOwner	StaffIssued	AcencyReferred	StaffReferred	DateResolved	Comment
2/22/2005	Un-mapped ponds and outfall east of 20th Ave	W7.82	117892864	SOLMONSON DONALD W & SANDRA	Szwaya	Clark County	Henry Schattenkerk	ongoing	Facility needs to be mapped
2/24/2005	Small hole in swale of facility above eroding gully	W6.26T0.00	185575168	CLARK COUNTY	Wierenga	Clark County	Ken Lader	ongoing	Ken referred to Jeff Tuttle to fix hole
2/24/2005	Strong odor of chemical (solvent?) in tributary to Whipple Creek	W5.70T1.08S	118107676	VALENTINE FAMILY LTD PTNSP	Schnabel	Ecology	Curt Piesch	2/25/2005	Site visited by Curt, Ron W., and Cary A. Solvent odor not present but potential issues noted (see below)
2/25/2005	Business has stormwater runoff issues on site	W5.70T1.08S	118107676	VALENTINE FAMILY LTD PTNSP	Wierenga	Clark County	Cary Armstrong	3/15/2005	Cary visited site with Kim Kagelaris and Marlou Pivirotto. Solvent issues found and actions pending
2/28/2005	Need to coordinate with Dave Howe about Whipple Creek property	W7.82;W8.36	181935000	VAN BUREN HELENE HIDDEN TRST	Schnabel	Clark County	Dave Howe	3/2/2005	Dave notified of WC Project, Jeff requested WR contribute CWP funding toward purchase
3/1/2005	WSDOT is doing an inventory along I-5; need to coordinate if possible	reaches on I-5 corridor	NA	NA	Schnabel	Clark County	Rod Swanson	3/3/2005	Rod contacted Erin Gardner at WSDOT. Clearing is eng. survey for upcoming I-205/I-5 interchange project
3/2/2005	Un-mapped facility near I-5	W7.06	185669000	LIES BRIAN S & LAURIE ETAL	Wierenga	Clark County	Ken Lader	3/10/2005	Facility needs to be mapped
3/2/2005	Un-mapped facility and inaccurate infrastructure mapping	W7.06T0.74N	117894650	Clark County	Schnabel	Clark County	Ken Lader	ongoing	Facility and area need mapping investigation
6/2/2005	Possible presence of threatened species (red-legged frog)	W6.44T0.00	NA	NA	Wolf	WDFW	staff biologist	6/2/2005	Frog not positively identified, but likely red-legged. May be listed as sensitive species in future
3/8/2005	Un-mapped facilities and infrastructure at fairgrounds and amphitheatre	W9.14T0.54S; WT6.41T1.01N; W7.82T0.22; W6.44T0.53E	182148000; 182213000; 182214000	Clark County	Wierenga	Clark County	Henry Schattenkerk	3/10/2005	Facilities need to be mapped
3/7/2005	County soil surplus site has site drains routed through silt fence	W9.14T0.54N	116530000; 116521000; 116520000	Tehennepe, Dubravac	Schnabel	Clark County	Cary Armstrong	3/9/2005	Cary to Sheila Pendleton. Sheila to Charlie Hord (Construction Mgmt). Drains re-routed inside fence
6/2/2005	Livestock access to stream-- impacted streambank and riparian area	W7.06	185749000; 185741000; 185747000	LIES RUDY & MARY ETAL CONT	Schnabel	Clark Conservation District	Denise Smee	ongoing	Conservation District may wish to contact landowners regarding livestock fencing
6/2/2005	Livestock access to stream-- impacted streambank and riparian area	W7.82T0.22	182139000; 182154000	GONZALES LL0YD ETAL; OLSON STEPHAN E & ALLISON L	Schnabel	Clark Conservation District	Denise Smee	ongoing	Conservation District may wish to contact landowners regarding livestock fencing
6/21/2005	Possible septic system issues	W8.50	181904000; 181936000	WOOLEY RICHARD & GLENNYS; SIMMONS CHARLES F & RUTH C	Schnabel	Clark County Health Dept	Steve Keirn		Health Department may wish to inspect these two parcels for septic issues
6/21/2005	Unidentified pipe outfall may be related to septic drainfield	W7.06T0.00	185404000	BAXTER DONALD & KAREN	Schnabel	Clark County Health Dept	Steve Keirn		Health Department may wish to inspect this parcel for septic issues
3/22/2005	Bank stabilization problem at PW county's Sara planting site	P0.00	182705000	CLARK COUNTY	Wierenga	Clark County	Heath Henderson	ongoing	Forwarded info to Phil Gaddis to address
3/22/2005	Freshwater mussel bed in lower Whipple Creek	W3.85	182659000	BENES MICHAEL & CATHY	Wierenga	USFWS	Jennifer Poirier	3/25/2005	Jennifer responded with interest in the beds; may use site in upcoming volunteer training
4/5/2005	Large animal track needing identification	P1.67	180742000	HOFFMAN SALLY R	Wierenga	USFWS	Donna Allard	4/8/2005	Steve Engel identified as very large canine track, probably not feline
4/7/2005	Large amount of debris piled up next to stream	P1.06T0.49W	179831000	MEYER KEVIN D	Wierenga	Clark County	Cary Armstrong	ongoing	
4/14/2005	Severe off road vehicle impact to stream	P2.06T0.00N	179698000	SHIPP STEVE & DEBRA CONT	Wierenga	Clark County	Cary Armstrong	ongoing	Cary referred to Scott Melville, CE officer
6/21/2005	Strong sewage odor from SW outfall	P1.06T0.49W	NA	CLARK COUNTY	Schnabel	Clark County	Steve Keirn		possible inspection, or include in Illicit Discharge project
3/31/2005	Livestock access causing stream bank erosion and riparian impact	P1.23T0.98S	182378000	NYE MARTIN & CHERIE	Schnabel	Clark Conservation District	Denise Smee	ongoing	Conservation District may wish to contact landowners regarding livestock fencing

Appendix D – Watershed Characterization Maps




Whipple Creek
Stream Assessment
Bank Erosion and
Floodplain Connection


Whipple Creek
Stream Assessment
Channel Substrate and
Fish Barriers
Legend
Watershed
10 ft Contours
100 ft Contours
Hydro Edge
Parks, etc
Beaver Dams
Severity Rating
large
small
Channel Substrate
n/a
Gravel (0.1-2.0")
Sand (gritty)
Silt/Clay (loose/sick)
Stream Crossing
Severity Rating
most severe
least severe
no effect
No Value
MAP NOTES

Appendix E – Example map of assessed features